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PHOTOGENIC MARINE ANIMALS.

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The photogenic property, or phosphorescence, of marine animals has been a subject of interest to naturalists and the general public for ages—long before the experiments of the old alchemist, Vincenzo Cascariolo, of Bologna, made the phosphorescence of mineral substances familiar to the chemist. Cascariolo, though he did not extract gold from heavy spar, found that the sulphuret of barium, often called "solar phosphorus" or the "Bologna stone," shone in the dark after exposure to the sun's rays. Chemists now recognize that easily oxidizable substances give out light, *e.g.* phosphorus, sodium, potassium, ether, aldehydes, besides radium, and many organic compounds. Fluor spar and felspars emit light when slightly heated on a shovel, whilst a cylinder of lime glows visibly when it is rotated before a jar-spark. Other substances, such as calcium sulphide, after exposure to almost any source of white light, gleam with a bluish phosphorescence. Phosphorescence by heat, indeed, formed the subject of one of the many papers published by Sir David Brewster, long the Principal of this University, and whose great labours and distinguished reputation still shed lustre on St. Andrews. Certain substances, again, emit light in process of cleavage, by friction, by percussion, or whilst crystallizing; and there are also phosphorescent gases. The photogenic properties of various substances and gases discovered by Sir James Dewar in his remarkable experiments with liquid air still further enlarge the field. Mr. Herbert Jackson, from whose lecture* part of the foregoing is quoted, considers that these phenomena may be looked upon as outward evidences of response on the part of the substances to rapid oscillations, whether these oscillations have their origin in chemical combustion—in what is commonly spoken of as light—or in electrical discharge. The nature of that response may in some cases be of a direct character, but when account is taken of the many degrees of persistence of phosphorescence it seems in many cases first to assume the form of a statical change. The release of this condition of strain is accompanied by oscillations which give rise to the visible undulations of phosphorescent light.†

Since the discovery of phosphorescence in the garden *Nasturtium* by a daughter of Linnæus—the same who delighted herself, as Arago also did, by setting fire to the inflammable atmosphere surrounding the oil-glands of certain species of Dittany (*Fraxinella*)—this phenomenon has likewise been known to the botanist. Phosphoric light is emitted by various plants, such as the sunflower, marigold, orange lily, certain Fungi, and Bacteria.

Placed as we are on the shores of the North Sea, this striking phenomenon must be familiar to most of us—even those who do not go down to the sea in ships—for it is but necessary to stir the stranded seaweeds at night on the east or the west sands after a storm to find every blade sparkling with brilliant points, which glimmer and twinkle like miniature stars. In the sea itself, however, the phenomenon is seen in great beauty, for, leaning over the side of a boat in July or August, the wavelets are seen to gleam with phosphorescent points; whilst behind a ship the brightly sparkling and seething mass—here and there with circles of fire at the screw—merges into a long trail of luminous

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* Lecture to the British Association, 'Nature,' Oct. 6th, 1898.

† Physicists state that when the wave-length is greater than 812 millionths of a millimetre no luminous effect is produced on the eye, though the effect on the thermometer may be great. When the length is 650 millionths the ray is visible as red light, and when 500 millionths of a millimetre it is brilliant green, but has much less heating effect than either of the foregoing.

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water stretching far into the darkness. Every stroke of the oar causes a luminous eddy, and minute forms are lifted by the blade, and scintillate brightly as they roll into the water. Nor is the phosphorescence limited to surface-forms, for many luminous types of great interest and beauty are brought up by dredge and trawl, even from great depths.

Sixteen years ago I gave an address on the subject of the phosphorescence of marine animals to the Biological Section of the British Association at Aberdeen. Since that date noteworthy progress has been made only in two departments, *viz.* (1) in that of photogenic Bacteria, those minute plant-organisms which play so important a part in causing dead food-fishes, for instance, to gleam in the dark; and (2) in the extension of our knowledge of luminous fishes.

As a general rule phosphorescence in marine animals shows itself under four conditions, three of which are connected with structure:—

(1) The animals present special cells which, under certain circumstances, secrete a phosphorescent mucus.

(2) The special cells produce light without mucus or other visible secretion.

(3) The animals emit light under the action of the nervous system without special differentiation of the tissues.

(4) Their phosphorescence is due to photogenic Bacteria.

In the first three the light is emitted on the slightest touch, or, in some cases, by simply blowing on the animal producing it. It varies in colour from pale lambent light through several shades of pink, red, green, lilac, and blue; while Huxley found that *Pyrosoma* at its brightest was red, but in fading it passed through shades of orange, green, and blue. Further, the light disappears on the death of the animal. In the fourth group, on the other hand, the luminosity occurs about a day after the death of the fish.

Phosphorescence is found in almost all the great subdivisions of marine animals up to and including fishes, *viz.* in the simplest forms, *viz.* Protozoa, in Cœlenterates, Worms, Rotifers, Crabs, Shell-fishes, and Fishes. Moreover, every variety of marine life is represented, such as pelagic (or swimming and floating), sedentary, and reptant. Some of the phosphorescent animals inhabit tubes, and it was the brilliant luminosity of these that led, in 1870, to doubts as to the correctness of the views entertained by the distinguished naturalists of the 'Porcupine' Expeditions, and especially by the late Sir Wyville Thomson, *viz.* that this attribute served the two diverse purposes of attracting prey or of alluring enemies. The naturalists of the 'Porcupine' were struck by the phosphorescence of many of the forms living at great depths in the Atlantic, such as Alcyonarians, Brittle-stars, and Annelids. In some places the mud itself was full of luminous specks. Accordingly, they broached the idea that the abyssal regions might depend for light solely on their phosphorescent inhabitants. Moreover, since the young of certain Star-fishes are more luminous than the adults, it is probable that this is part of the general plan which provides an enormous excess of the young of many species, apparently as a supply of food, their wholesale destruction being necessary for the due restriction of the multiplication of the species, while the breeding individuals are provided with special appliances for escape or defence. For example, a young *Hyas araneus*, having dense tufts of a phosphorescent zoophyte waving from its shell and limbs, must, on the one hand, like an Indian beauty with her fireflies, be the cynosure of all (predatory) eyes; and, on the other, be enabled to throw such a flood of light on the food-question as to distance many rivals. This view, however, had long been known to naturalists. Thus Dr. Coldstream, in Todd's 'Cyclopædia,' observes:—"Considering that in the ocean there is absolute darkness at 800 or 1000 feet (133 to 166 fathoms), at least that at such depths the light of the sun ceases to be transmitted, Macculloch has suggested that, in marine animals, their luminousness may be a substitute for the light of the sun, and may be the means of enabling them to discover one another, as well as their prey. It seems to be particularly brilliant in those inferior animals which from their astonishing powers of reproduction, and from a state of feeling apparently little superior to that of vegetables, appear to have been in a great measure created for the supply and food of the more perfect kinds."

If, as the 'Porcupine' naturalists say, luminosity subserves the purpose of guiding animals to their prey, or of causing them to be preyed upon (an unfortunate result), or even of illuminating the abysses of the ocean, it might be supposed that traces of a general resemblance in habits, structure, or physiology would be found, and which would at least indicate the bearings of a provision so important. Thus, for instance, a similar state of matters might be expected in the dark caverns of Illyria and Dalmatia, or in those of the mammoth caves of Kentucky.

On surveying the marine animals possessed of this property of phosphorescence, however, they are found to live under circumstances so diverse that it is truly difficult, not to say hazardous, to promulgate any theory of the foregoing kind in connection with this manifestation.

The lowest forms (Protozoa) which show emissions of light are certain Infusoria, e.g. *Ceratium* (considered by some to be an alga) and *Porocentrum*. Our waters teem with multitudes of these, the tow-net in July and August being coated with them, *Peridinium*, and others; and if, on removing it from the water at night, it is suddenly jerked, the whole interior is lit up with a luminous lining, which glows brightly for a few seconds and then fades. The same forms cause the crest of each wave as it curls from the sides of the boat to sparkle vividly. Other phosphorescent Protozoa are the Radiolarians—*Collozoum*, *Sphærozoum*, and *Thalassicolla*—which Giglioli found to shine with an intermittent greenish light in the Pacific. No member of the group, however, is so well known for its photogenic properties as *Noctiluca*, a minute, transparent, gelatinous sphere, which is very widely distributed throughout the warmer seas. Its minute size and vast abundance probably gave rise to the old notion that the luminosity of the sea was due to the water itself, and not to any visible organism. Thus an ecclesiastic named Tachard (1686) considered that the water absorbed the light of the sun by day and emitted it at night; whilst Robert Boyle attributed the phosphorescence of the waves to friction with the air.* To M. Rigaut, an acute French surgeon, belongs the credit of being one of the earliest observers to prove that the phosphorescence of the sea off the French coast and off the Antilles was due to this organism, which he called a little spherical polyp. It occurs in vast swarms in most of the great oceans, and even off the southern and western shores of Britain, and is the cause of that diffused silvery phosphorescence so familiar to voyagers. De Quatrefages attributes the emission of the clear bluish light of this species in quiet water, or the white light with greenish or bluish touches in broken water, to any physical agent which produces contraction, the large number of minute scintillations arising from the rupture and rapid contraction of the protoplasmic filaments in the interior.

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* Phipson, 'Phosphorescence,' p. 174, 1862.

In this connection Watasé has recently made some interesting remarks on the relationship of protoplasmic contractility and phosphorescence. The physicists have shown that heat and light are simply variations of the same radiant energy. The heat-producing particles and the light-producing particles, objectively considered, may not be very different from each other. "They may be variations of similar chemical substances, as the resulting energies, the products of their oxidation, are the variations of the same radiant energy. The stimuli, therefore, which induce combustion of the thermogenic molecules may also be presumed to incite combustion of the photogenic molecules. The luminosity is due to the metabolism of the definite tissue-cells and the subsequent oxidation of the metabolic product, resulting in the emission of light." The luminous tissue gives out carbon dioxide.

In the open sea the naturalists of the 'Challenger' found *Pyrocystis*,* a form closely allied to *Noctiluca*, the light from which is stated to proceed from the nucleus. Sir Wyville Thomson observed that when shaken in a glass it gave out the uniform soft light of an illuminated ground-glass globe.

Several authors have mentioned phosphorescent sponges, but there is considerable dubiety. Parasitic luminous forms are numerous in sponges, and in some cases misinterpretation may have occurred.

In no group has phosphorescence been longer known, is more general in its distribution, or more beautiful in its manifestations than in the Cœlenterates, comprising Zoophytes, Jelly-fishes, Sea-pens, and Sea-fans. On our own shores the tidal region, the laminarian zone, the coralline, and deep sea areas are equally the home of luminous representatives.

The Hydroids (or Zoophytes, as they are often called) are familiar examples, and it is only necessary to lift a handful of such as are captured by the deep-sea liners or trawlers at night to see the whole mass glittering with a hundred stars. None, indeed, as the late able and conscientious observer, Mr. Hincks, says, excels the common *Obelia geniculata*, which forms pigmy forests on the broad blades of the tangles. In the fresh specimens a touch during July causes a large number of luminous points to appear, the stems most irritated exhibiting beautiful flashes, which glitter like faintly dotted lines of fire, the points not being boldly separated, but blending into each other; whilst the shock imparted by the instrument detaches the minute Medusa-buds, which scintillate from the parent stem upwards to the surface of the water. By blowing on the surface where tangles abound the pelagic buds at once emit light. Moreover, these minute bodies, along with various species of *Ceratium*, are sometimes swept by gales landward, and cause luminosity in unwonted quarters. Thus the late Dr. Cowie, of Lerwick, when riding at night along Deal or Dale's Voe, in Shetland, during the presence of a south-westerly gale, happened to touch his beard, when it and his hand gleamed with phosphorescent points, a feature akin to the old experiment of Pliny, *viz.* rubbing Medusæ on a plank of wood. The gale had swept the spray and its minute inhabitants on the person of the rider. In the same way Vaughan Thompson found luminous patches on the masts and windward yardarms on board ship, and they gradually mounted upward as the gale increased. Many of the free Medusa-buds are as luminous as the polyps, and the light (*e. g.* in *Thaumantias*) gleams round the margin of the disc and along the four radii.

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* As described by Sir John Murray.

Giglioli mentions that certain oceanic forms, *viz.* Siphonophora, are likewise characterized by phosphorescence. Dr. Bennett and the same author also found the coralligenous Actinozoa and Madrepores luminous, the light in the latter being greenish and lasting some minutes. The Acraspedote Medusæ show many luminous species (e. g. *Pelagia*, *Rhizostoma*), though neither of the common forms on our coasts (*Aurelia* and *Cyanea*) present this feature. In the luminous Medusæ the presence of certain cells containing highly refractive granules akin to fatty cells has been demonstrated.* On stimulation the light is emitted (in *Pelagia*), and conveyed to the whole external epithelium.

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* Watasé.

Many of the Ctenophores are luminous, and in our own seas *Beroë* at various stages is one of the most prominent. Their enormous numbers in quiet seas like Bressay Sound and the Firth of Forth make the effects more striking, though the intensity of the phosphorescence is less than in the Medusæ. The photogenic material is distributed along the gastro-vascular tracts of *Beroë*. *Lesueuria*, again, which is met with in multitudes in St. Andrews Bay, has a bright bluish (steel-blue) light. Moreover, as Prof. Alex. Agassiz observes, the phosphorescence is equally brilliant in the egg, even in its earliest stages (as in *Lampyris*). It is only necessary to give the jar a shock, when each egg of *Pleurobrachia* becomes brilliantly luminous. There can be no special glands (as Panceri describes in other forms) in such a case, but the protoplasm of the egg, as Watasé supposes, probably contracts and emits the light.

The Sea-pens amongst the Alcyonarians are perhaps the best known and most beautifully phosphorescent forms, especially the common species so abundant off the Firth of Forth. Panceri found that the light proceeded from eight white cords adhering to the outer surface of the alimentary canal of each polyp, and that the cells of these contained a substance of a fatty nature, the oxidation of which caused the light, and there were also multipolar cells containing albuminous granules. On irritation the light, after a brief interval (four-fifths of a second—Panceri), flashes along the rows of polyps in a somewhat irregular manner. The larger *Funiculina* and *Umbellularia* are equally phosphorescent; the former, according to Sir Wyville Thomson, is resplendent with a steady pale lilac phosphorescence like the flame of cyanogen, and always sufficiently bright to make every part of a stem caught in the tangles distinctly visible. He mentions also that *Umbellularia* is so brightly phosphorescent that it is easy to determine the character of the light; while, with respect to the Corals, *Isis* and *Gorgonia*, he conjures up a Gorgonian forest at a depth of six hundred fathoms off the Spanish coast as like an animated corn-field waving gently in the slow tidal current, and glowing with a soft diffused phosphorescence, scintillating and sparkling on the slightest touch, and now and again breaking into long avenues of vivid light, indicating the paths of fishes and other wandering denizens of these enchanted regions.

There are comparatively few luminous members of the group of Echinoderms, the most conspicuous being the common Brittle-star (*Ophiothrix*), and one or two allied genera, besides the curious *Brisinga*. Sir Wyville Thomson describes the light of *Ophiacantha* as of a brilliant green, coruscating from the centre of the disc along the rays, and illuminating the whole outline of the Star-fish. The common Brittle-star from deep water gleams all over the trawl-net with a pale greenish light, but the adults between tide-marks show no trace of luminosity. The light from a hundred examples of *Brisinga* is very brilliant. The naturalists of the 'Porcupine' were of opinion that the young stages of certain Star-fishes were more luminous than the adults in order to act as a check on their increase, but the condition in non-luminous Star-fishes and in other young invertebrates would seem to throw doubt on this view. There are no data, indeed, to show that a luminous form is more eagerly preyed on than one which is not.

Phosphorescence is stated to occur in certain Planarians and Rotifers, and a species of Sagitta; but it does not appear to be a common manifestation in the lower worms. On the other hand, the luminosity of the Annelids is brilliant, and has been noted from early times. The representatives of five families of Annelids possess this property, yet there is nothing specially different in the habits of these from those in which this feature is absent. In the family of the *Polynoidæ* no less than six or seven British species are phosphorescent. One of the most abundant between tide-marks is *Polynoë floccosa*, which emits greenish scintillations from the point of attachment of the scales, and in a double moniliform line along the ventral surface. It lives under stones. Others, such as *Gattyana cirrosa* and *Polynoë scolopendrina*, frequent the tubes of Terebellids, whilst *Achloë* haunts the ambulacral grooves of Star-fishes (*Astropecten*). Though Dr. Jourdan is of opinion that in *Polynoë torquata* the luminosity is produced by cells secreting mucus, it would appear that in the majority of the *Polynoidæ* no secretion of mucus is present. It may be that, as Watasé observes, the light-giving material is formed by the secretory process of the protoplasm, accumulates along the course of the muscle-fibres, and manifests itself in sparks or scintillations in the line of the ventral longitudinal muscles.

In the *Syllidæ* the widely distributed *Eusyllis tubifex*, so abundant in transparent tubes on tangle-blades, is one of the most conspicuous examples. Under irritation a fine green light is emitted from the ventral aspect of each foot, and the scintillations seem to issue from many minute points at each area, flash along both sides of the worm posterior to the point of stimulation, and then disappear. Under severe irritation the animal remains luminous behind the injured part for nearly half a minute, while the surface of granular light in each segment is larger than usual, and in some instances the areas of opposite sides are connected on the ventral aspect by a few phosphorescent points. The body behind the irritated region has a pale pinkish hue immediately after the emission of light, showing that the luminosity is diffused. In this family the emission of light seems to be due to the same physiological process as in the *Polynoidæ*—no mucus being secreted.

In the family of the *Chætopteridæ*, as in the common species in the South of England and the Channel Islands, the phosphorescence is very beautiful, bright flashes being emitted by the posterior feet. The most vivid luminosity, however, is at a point between the lateral wings of the tenth segment, where a quantity of mucus is secreted, and which can be drawn out as bluish purple fire of great intensity, the light gleaming now and then along the edges of the wing-like processes—at once illuminating the surrounding water, and eliciting the admiration of the observer. In all probability, in this case, the oxidation of the secretion by the oxygen in the water suffices for the production of light. A very characteristic odour similar to that of phosphorus in combustion is given out by the animal during such experiments, and Quoy and Gaimard formerly observed that an odour resembling that around an electric machine is emitted by luminous marine animals.

Our patient and laborious countryman, Sir John Graham Dalzell, noticed that when irritated *Terebella figulus* gives out a copious blue refulgence intermingled with a reddish flame.

Grube subsequently found that *Polycirrus* likewise excels in the brightness of its phosphorescence, and the ease with which it is elicited. Mere blowing on the water of the dissecting-trough suffices to produce it in the British species—the most vivid pale bluish luminosity gleaming for a moment along every one of the mobile tentacles, often elegantly disposed in a stellate manner. *Thelepus*, another example of the group, is only faintly phosphorescent during life, but when decomposition has advanced it shines in the water with a pale lambent light, somewhat like phosphorus in air. The transparent pelagic *Tomopteridæ* present on the feet certain peculiar structures which were formerly supposed to be eyes or simply glandular organs. Greef found these to be luminous.

So far as can be observed in this group, *viz.* the Annelids, there is little in the habits or surroundings of the phosphorescent species to explain the occurrence of the phenomenon. The most diverse conditions prevail. Thus *Tomopteris* is pelagic throughout its entire existence. *Polynoë floccosa* lives in the free condition under stones between tide-marks, while those of the same genus are commensalistic with the *Terebellidæ* in tubes. The phosphorescent species of Terebellids are tubicolar, or occur in fissures of rocks. *Chætopterus* dwells in tough tubes of a parchment-like secretion covered with pebbles, stones, shells, and seaweeds. To suppose that the Polynoids attract prey for the benefit of the Terebellæ or themselves is to endow them with properties analogous to those the older naturalists ascribed to the Pea-crabs in the Horse-mussel. It is unlikely that they are furnished with light to attract marauding fishes or Crabs, for they are in tubes immersed in sand, beneath stones, or in obscure chinks and fissures of muddy rocks, boulders, and old shells. It can hardly be affirmed that they are protected because they are luminous, since many species which are not so have exactly the same habits and shelter; while other phosphorescent forms are either pelagic or devoid of such a safeguard. No reliable deduction can be made as to the function of this endowment.

Amongst the lower marine Arthropods one of the most interesting examples occurs in a gigantic Pycnogonid (*Colossendeis gigas*), recently dredged by Dr. Alcock at 922 fathoms near the Andaman Islands. It is blind, and appears to feed on oceanic mud, so that its luminosity is useless to itself in procuring food; and, since the animal is, as it were, all slender legs, with a span of nearly twenty inches, it would not form a tempting bait for any fish. Dr. Alcock* placed it ventral surface upward in a dark cabin, where it shone like a star, the body and all the legs except the egg-bearing pair showing as lines of persistent blue-green light. This gradually died away, but remained for a long time illuminating the long fifth and sixth segments of all but the first pair of legs. The theory of the 'Porcupine' naturalists gains little support from this form.

Occupying a similar position to the myriads of other Arthropoda, such as insects, spiders, and centipedes on land, the group of marine crustaceans rivals them in the enormous numbers of its representatives. Amongst these luminosity occurs in the minute Copepods (whose vast numbers and ubiquitous distribution make them so important in connection with the nourishment of young fishes and even of Whales), in *Sapphirina*, a member of the same group, in various Schizopods, and in the higher or decapod crustaceans. In some of the minute types, such as the Copepods, the phosphorescence has been attributed to the food in the interior. In a similar way the luminous Sandhopper (*Talitrus*) was found by Giard to have photogenic Bacteria parasitic in its abdominal cavity, and they by and by entered the organs, causing its death. During the disease the animal emitted a green light, which ceased a few hours after death. In the Schizopods the Opossum Shrimps (*Mysidæ*), *Euphansia*, and *Lophogaster* (*Gnathophansia*) have luminous organs, which have often been regarded as eyes. They have bright red pigment, and are situated on the thorax and abdomen. Sars† describes the essential part as the fibrous fascicle lying in the centre of the globular corpuscle. The lenticular corpuscle placed just in front of this acts as a condenser, and a glistening ring round the lens resembles an iris. Muscles, moreover, move the organ. The diaphanous front and the red pigment of the posterior part also lead to the assumption of the close resemblance to a vertebrate eye. He, however, found, on experimenting with the living animal, that they had nothing to do with vision. Perrier, on the other hand, thinks they have. Flashes of light proceed from these organs, and when dying the whole body is frequently diffusely luminous. Similar organs are found in *Nyctiphanes norvegica*, the phosphorescence of which was observed by Sars, and afterwards by G. J. Murray, in the Faroë Channel. This species often appears in vast numbers on the east and west sands, St. Andrews, where their stranded multitudes resemble chaff, and along with them is *Thysanoessa*, the luminous globules of which agree in structure with the foregoing.

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* 'Zoological Gleanings,' 1901, p. 74.

† 'Challenger,' vol. xiii.

In certain crustaceans (*Leucifer*, *Aristæus*, and probably in *Munida* and *Dorynchus*) the eyes are brilliantly phosphorescent. In species of *Aristæus*, *Heterocarpus*, and *Pentacheles*, recently dredged by Dr. Alcock* off the Andaman Islands, luminosity also occurred. In the two former the light appeared to come as a secretion near the openings of the green glands. *Heterocarpus* (both male and female), as it floated in a dark cabin, emitted clouds of light, which at last lit up the bucket, so that all its contents were visible in the clearest detail; but the luminous secretion of a female *Aristæus* was neither so bright nor so lasting. In *Pentacheles* (female) the light was confined to two points near the openings of the ducts for the eggs.

The majority of the luminous crustaceans are either pelagic or abyssal, and the habits of those endowed with this property do not appear to differ from those which are not.

It has been asserted that some of the Bryozoa (Molluscoida), e.g. *Scrupocellaria reptans*, *Membranipora pilosa*, and *M. membranacea*, are luminous, but such has not been observed here. They may, however, owe this property to luminous Bacteria.

The phosphorescent mollusks are represented by bivalves and univalves, and some have been known for a very long time. Thus Pliny mentions *Pholas dactylus*, which Panceri found to have a luminous border to the mantle, two patches and two long ridges in the branchial siphon. The special epithelium of these parts secretes a phosphorescent substance—soluble in ether and alcohol—which illuminates the excurrent water and the lips of those who eat them. The light is also maintained for a long time during putrefaction, as in the annelid *Thelepus*. The French chemist, Dubois, separated two substances from the light-producing tissues of *Pholas*—one crystalline which is soluble in alcohol, essence of petroleum, benzine, and ether, which he called luciferine; the other albuminoid, which he termed luciferase. As this mollusk—the "Pierce Stone" of Petiver—inhabits the holes it bores in rocks, and lives on minute forms carried in by the branchial current, it would be difficult to frame any theory—on the basis proposed by the naturalists of the 'Porcupine'—which could be adapted to it.

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* 'Challenger,' vol. xiii. p. 74.

Several Pteropods are likewise luminous, according to Giglioli, *viz.* a *Cleodora*, which gives out a vivid reddish light, a *Creseis*, and a *Hyalæa*, which are phosphorescent at the base of the shell. An unknown Heteropod in the Indian Ocean also glowed with a reddish phosphorescence. The curious *Phyllirhoë*, a pelagic Opisthobranch, which is found in the Atlantic, in the Pacific, and in the Mediterranean, presents (in *P. bucephala* of the latter sea) a vivid azure luminosity, chiefly at the superior and inferior borders of the body, but no luminous mucus is exuded. Panceri considered that the contents of certain cells (cells of Müller) placed in the vicinity of fine nerves produced the light under the action of a stimulus.

In the highest group of mollusks, *viz.* the Cuttle-fishes, phosphorescence occasionally occurs. Giglioli observed that *Loligo sagittatus* and a small *Octopus* gleamed all over with a whitish luminosity. The same has been noticed in *Cranchia scabra*, Leach.

The Tunicates or Urochordates show several striking examples of luminosity. Thus Agassiz and Giglioli found the notochord of an Appendicularian glow with a rich red, then azure, and finally with green. No luminous British form has yet been observed. One of the best known, however, is *Pyrosoma* from the warmer seas, so graphically described by Péron, Huxley, Panceri, and others, and one gigantic example of which was found by the 'Challenger' four feet in length. This colonial yellowish-white form, under irritation, glows with red, golden, orange-green, and blue, the light proceeding in each member of the organism from two small oval patches of cells at the base of each inhalent tube. These cells contain substances resembling fat and albumen, and their membranous sheath is bathed by the blood of the lacuna. The luminosity ceases with the life of the colony. *Salpa*, also, is usually classed amongst the luminous types, especially those in tropical and subtropical waters. Certain species are stated to give out a bright red light from the nucleus, the photogenic granules formed in the blood-corpuscles being oxidized by the oxygen dissolved in the blood-plasma. Amongst the multitudes of *Salpæ* (*S. runcinata* and *S. spinosa*) examined for some weeks in the Outer Hebrides, no clear case of luminosity was seen. A spark occasionally appeared in the nucleus of some specimens, probably from the food. *Doliolum*, on the other hand, is described by Giglioli as shining with a greenish luminosity over the whole surface.

So far as can be observed, there is nothing in the habits of the luminous Tunicates to distinguish them from those of the non-luminous.

The literature of the so-called phosphorescent fishes extends from the days of Aristotle and Pliny to modern times, Ehrenberg, for instance, giving a list of about fifty fishes stated to be luminous, though a considerable number are doubtful. Our knowledge of the photogenic properties of living fishes, on the other hand, is for the most part comparatively recent—in fact, is mainly due to the voyage of the 'Challenger.' These luminous fishes divide themselves into two groups, *viz.* pelagic fishes and deep sea or abyssal fishes (below one thousand fathoms). So far as known, no littoral fish and few gregarious food-fishes (Teleosteans) show this property in any marked degree during life.

In many of these luminous forms the mucous canal-system of the head and body is largely developed, and the mucus which it secretes is phosphorescent; but in others special photogenic organs are present, the distribution of which is subject to great variety. De Kerville* has collected no less than nine modifications of the disposition and structure of those special organs of luminosity. In the first or primitive condition they appear as numerous minute tubercles scattered over the skin, and covering the sides of the body (Ex. *Pachystomias*). 2nd. Larger but less numerous nodules on the skin of the head and body (*Xenodermichthys*). 3rd. Two rows of reddish or green eye-spots ranged at regular intervals on the sides inferiorly, on the head, at the base of the branchiostegal rays and the operculum

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* 'Challenger,' vol. xiii. p. 162.

(Ex. *Stomias*). 4th. Large, rounded, and flattened perlaceous organs distributed on the sides of the body inferiorly, on the head, operculum, and sides of the base of the tail (*Argyropelecus*). 5th. Spots of a white glandular substance, which may be, in the various species, on the sides of the body, on the dorsal or ventral surface of the tail-peduncle, near the clavicles on the branchial cavities, on the infra-orbital region of the maxillaries, on the summit of the muzzle in front of the eyes, on the barbels, and on the fin-rays. 6th. In this group the associated glands form bands in the infra-orbital region (*Idiacanthus*). 7th. The photogenic apparatus of the dorsal fin is differentiated, having the form of a cavity with an orifice and a filament (*Ceratias*). 8th. The diamond-shaped organs form a single row on the scales of the lateral line, and on the inferior branches of the muciparous canals of the head. They are situated beneath the semitransparent integument, but are independent of it (*Halosaurus*). 9th. Two symmetrical photogenic organs lie on the snout to the right and left of the median line—from the nasal cavities to the posterior of the cranial cavity (*Inops*).

Like some previous authors, De Kerville is of opinion that such fishes play a considerable part in the illumination of the abysses of the ocean, and that the varied distribution of the photogenic organs proves that the production of the light is dependent on the uses to which it is applied. Thus he makes two groups:—*a*. Those which have the general luminosity for pointing them out to others which seek them as prey, the light probably ceasing during repose. Those with brightly luminous organs on the head near the eyes use it, he thinks, for searching out their prey. *b*. The second group includes those in which the photogenic organs are situated on fin-rays or tentacles, apparently for the purpose of attracting animals to serve as food, since it is well known that marine animals are attracted by light. Moreover, this arrangement occurs in certain fishes with the eyes little developed. When the organs are on the tail they also attract prey, which is thus brought within reach of the agile possessors (such as the *Scopelidæ* and *Sternoptychidæ*). It can hardly be urged that these luminous organs intimidate their enemies. The notion of Perrier that the eyes of certain abyssal fishes are phosphorescent he regards as doubtful.

Though it is many years (1840) since Dr. Bennett captured, at the surface of the sea during a whaling voyage, a small Shark which emitted spontaneously a general and vivid greenish luminosity—with the exception of a ring round the throat—as it swam at night, and for some hours after death, it is only recently that the labours of Johann* and Burckhardt have made us acquainted with the remarkable prevalence of luminosity in the Selachians. No less than eleven species, besides Bennett's form, have this property. The distribution of the luminous organs varies in almost every species; in some occurring on the ventral surface, in others along the trunk, on the bases of the fins, on the gill region, and on the head. These organs consist of small epidermal elevations, which present externally layers of epidermal cells, some of the lower containing a prismatic corpuscle, pigment, a basal strand of fibrous tissue, and a nerve. The whole surface supplied with these structures is lit up in the dark. Thus Beer, who examined *Spinax*, states that the entire ventral surface from the snout to the root of the tail glowed with a feebly shining greenish lustre, as if it had been impregnated with phosphorus, or had been coated with luminous paint—with this difference, however, that the luminosity appeared and disappeared at short intervals, but invariably increased in intensity before it vanished. It was vivid enough to enable him to see it at a distance of from three to four metres, equalling three to four yards (upwards). During life, therefore, the nervous system appears to control the emissions of light; and the glow after death is probably due to the loss of the inhibitory power permitting the continuous but final luminosity, arising from the oxidation of the cell-contents.

The varied distribution of these photogenic organs in both Teleosteans and Selachians would not seem to point to any definite purpose of allurement. The active habits of the Sharks, besides, would negative such a proposition. Their pelagic life, moreover, from the surface downwards, lends little support to the view which would illuminate the abysses of the ocean by such a provision in the fishes found only there. The splendour of the spectral colours of such as *Læmargus rostratus* during daylight in the Mediterranean may be cited as a source of allurement with as much reason as its luminosity.

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* Zeitsch. f. w. Zool., Bd. lxvi. 1899.

Besides the phosphorescence of living fishes there is another and even more familiar manifestation of this property in fishes within twenty-four hours after death, and which has given rise to many interesting experiments, such as those of Robert Boyle on dead Whitings,* and of Dr. Hulme on Herrings.† This is now known to be due to the presence of photogenic Bacteria which occur exclusively in sea-water. In the paper just quoted Robert Boyle mentions that he placed a luminous Whiting in the receiver of an air-pump, and found that it shone less on extracting the air. On being replaced in air it shone brightly. Dr. Nathaniel Hulme, again, demonstrated that the luminous condition of the Herring and the Mackerel disappeared on putrescence. He made a luminous solution from the fishes composed of two ounces of Epsom salts or "vitriolated" magnesia in two ounces of cold spring water. He extinguished the light of the luminous Herring by freezing, but it returned on thawing. Roasting and boiling extinguished the light, which did not return. It is curious to find that he regarded the light as a constituent principle of marine fishes, and that it is separated by the menstrum fitted to decompose it. He was further of opinion that no offensive putrefaction takes place in the sea, and that the flesh of marine fishes remains sweet for some time, and provides nourishment for other forms—an evident instance, he thought, of the wisdom of the Creator. Dr. Hulme apparently never had the opportunity of coming in contact with a mass of putrescent herrings drawn up by a trawl from the bottom of the sea.

These early experiments are quite consistent with what is now known, *viz.* that the luminosity of fishes after death is due to photogenic Bacteria. One of the best known and most widely distributed forms is a short thick bacillus (*Photobacterium phosphorescens*), an excellent account of which, with others, is given by Mr. J. E. Barnard.‡ These Bacteria are marked by a tendency to undergo involution and by polymorphism, some presenting at one time a rod-shape, at others a spirillum, whilst mixed forms are not infrequent. They are readily developed in ordinary peptone beef-broth gelatine, and no medium is favourable to their growth that does not contain soluble chlorides, or solutions resembling sea-water, *e. g.* sodic chloride, 26·5 grammes; potassic chloride, ·75 grammes; magnesia chloride, 3·25 grammes. They develop rapidly on the recently dead fishes, and cause them to be luminous. They take no part in the decomposition of fishes, and appear to be non-pathogenic, except in the instance already referred to, *viz.* Giard's Sandhopper. A supply of oxygen is necessary for the exhibition of their phosphorescence, and when grown in an atmosphere of oxygen the light is brilliant. When the production of light is hindered the amount of oxygen absorbed is less. All agents which affect the life of the organism also affect the production of light. The phosphorescent principle does not pass through a Berkefield filter.

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* Philos. Trans. 1667, pp. 591–93. † *Ibid.*, 1800, p. 161.

‡ Jenner Instit. Prev. Med., 2nd ser., August, 1899, pp. 81–112. Two plates.

In conclusion, few subjects are more striking than this light-producing property of animals, and hence such forms on land have always received much attention. Some have even been used by man for purposes of ornament, or, as the French authors call it, "charming caprice"—for instance, the fireflies in the dark hair of the Mexican ladies, occasionally as miniature lamps, or as a lure in fishing; whilst the Baya-bird of India fixes them (*Lampyris*) to mud to illuminate its nest—it may be for purposes of warning and protection.

As regards the photogenic marine forms no special utility has been found, though it is long since the Abbé Dicquemare proposed to utilize certain species for determining the position where they were found; and more recently Decharme thought *Noctiluca* might be made available for prognosticating storms.

Moreover, the observer is struck by the simplicity of the light-producing mechanism, and by the absence of heat. Thus the light of a firefly, or a *Pholas*, has no sensible heat, whereas a temperature approaching 2000° Fahr. would be necessary to make it by the usual processes, except the Geissler tube. So impressed were Prof. Langley and Mr. Vesy* with this feature that they contrast it with the enormous waste in all industrial methods of producing light. This waste in candle, lamp, or even gas-illumination generally exceeds ninety-nine parts in one hundred. It is least in sources of high temperature, like the incandescent light and electric arc, yet it amounts to the larger part. The authors, in view of this remarkable light without heat of the animals just considered, are of opinion that there is yet hope of obtaining an enormously greater result than we now do in the production of light.

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* "On the Cheapest Forms of Light," Americ. Journ. Sc., 3rd ser. xi. No. 236. August, 1890. Quoted also by Watasé in one of his able lectures on the Physical Basis of Animal Phosphorescence. Boston, 1896.

NOTES ON THE NESTING OF *TRINGA ALPINA*.

By Alfred Jackson.

On the Lancashire side of the Mersey, to the south-west of Warrington, lies a strip of marsh, so low that the high tides of winter often flood a great portion of it to a depth of over two feet. Upon a piece of slightly rising ground amid such a damp situation I have for the past three years found Dunlins nesting, but it was not till 1904 that I knew the nest of four eggs, discovered the previous year, belonged to that species.

On May 22nd, 1904, while patiently watching a pair of Redshanks that had a nest somewhere near, I heard a series of unfamiliar low notes—" wote, wote, wote, wote, wote "—and was quick enough to see a male Dunlin, in full summer plumage, alight. As the notes were repeated, I saw plainly, from the movements of his mandibles, that they came from the Dunlin. Presently he got up, flew in a perfect circle round me, while I, fearing to lose sight of him, watched closely, and was pleased to see him alight again not far from where he started. This flight around me (low over the grass) was repeated no fewer than seven times—evidently intended to entice me away—each time the bird alighting near the one particular spot where I began to suspect a nest. All the time, either flying or resting, he gave utterance at intervals to the low note, while his circular flight was never more than twenty yards from me. Twice he sprang up immediately after alighting, dropping down again near a clump of grass ten yards away, the second time disappearing into it. I had almost expected this, and, treading softly towards the spot, he rose out of the long grass at my feet, where I was delighted to find two newly-hatched young and two eggs. The two eggs were fertile, for I heard, on placing them to my ear, the chirping of the chicks inside, and their tapping the sides of the shells. The parent, on leaving the nest, flew low and rather awkwardly in getting away. The nest—just a hay-lined hollow—was little larger than a Sky-Lark's, though more hidden among the grass. There were other Dunlins bleating over the marsh, but I found no more nests that year.

In 1905, intending to make further observations on the species, I frequently visited the marsh. As early as April 24th, while still in flock, an odd Dunlin among them gave vent to the breeding "bleating" sounds. On May 6th the bleating was more pronounced. The Dunlin's "bleating, buzzing whistle" is usually uttered while descending—on motionless outspread wings—at an angle of about twenty-five degrees, and when the bleating ceases the wing-flappings are resumed. This bleating sound is a string of notes—" whiz-whiz-whiz-whiz-whiz-whiz "—following in quick succession, commencing high in the musical scale, and gradually descending; seeming to be within the compass of four notes, including all the intermediate intonations. They may be imitated by whistling with the point of the tongue, using the vocal organs to produce the "whiz," &c. With the Dunlin the sound is undoubtedly produced by the vocal organs, for once during the day we were some time before we could locate the bird uttering the sounds. Not a Dunlin could we see against the sky, and, the bleating recurring exactly from the same locality, our eyes were instantly directed to a Dunlin down among the marsh-grass, not twenty yards away, quite near enough to see the motion of his throat and mandibles in expressing the sounds. Finding he was being watched, he with two others of which we were unaware flew towards the river. Afterwards we many times heard Dunlins bleating from the ground, and sometimes while gliding through the air on quite a horizontal plane. On May 14th, before being long on the marsh, we felt sure there were two pairs of these birds with nests, and, after a long vigil, the low " wote, wote, wote " of a Dunlin reached our ears. (Though these low notes are usually uttered while either standing or in skimming flight low over the grass, it is more rarely given from a height in the air.) " What's that?" inquired my companion. " That," I replied, " is the breeding note of the Dunlin when they have eggs or young"; and after a while, fancying that it may have come from an unobserved passing bird, and hearing bleating further to the north-east, we resolved to go and investigate it. My friend had travelled but a short distance, when he called out—just as I saw a Dunlin rise before him—announcing four eggs. Now, this was the direction from which the low notes had issued, and the bird may have been calling while sitting. I hastened to get a glimpse of the beautifully-marked treasures, which lay in a tuft of springing grass, big ends upwards and outwards, in the form of a cross, completely hidden save from immediately above; (all the nests we have found were so hidden.) I proposed to retire sufficiently to allow of her return, just to make quite certain of its being a Dunlin, and, after a lapse of thirty minutes, a pair of these birds passed low over the nest, wheeling, and then over it again, finally settling by a marsh-pool. Tiring of our watch, we left to stretch our legs, and, returning some time later, flushed the bird from the nest; and, seeing the black patch on one side of the breast, we were satisfied as to its identity.

On May 21st, we had been on the marsh some time when I heard a sudden loud squealing, accompanied by the excited cries of Redshanks, coming from the direction of my friend two hundred yards away. At that moment I discovered a Dunlin's nest with two eggs, while my friend excitedly beckoned me to come and see his find—for he, too, had found a Dunlin's nest, with four lovely eggs on the point of hatching; we had found them simultaneously! The noisy "squealing" was the distressful cries of the retreating pair of Dunlins as they left the nest, and we had never heard the note before from the throat of this bird. Why were the Redshanks so alarmed? We suspect it was this unusual startling cry of the Dunlins, and they had chimed in on the impulse of the moment, scarcely knowing what had caused it.

June 11th saw me alone—from 9.30 a.m. to 8.30 p.m.—watching the habits of *Tringa alpina* in particular. Near one of the marsh-brooks I flushed a female Dunlin, which flew about me in such a manner that I suspected still another nest. Many a time she alighted within fourteen feet of me, at short intervals uttering the nesting "wote, wote," and occasionally, on springing up from the grass, the usual Dunlin whistle. The male joined her later, bleating as he came from a distant portion of the marsh. I discovered, this day, that when bleating and descending the bird's progress through the air is slackened, and after that performance the speed is resumed. Sometimes when gliding down to alight—even when dropping his legs to do so—this bird began with the bleating "buzz," ending with the low "wote, wote"; so that I feel certain the bleating is a combination of the ordinary Dunlin whistle prolonged and the low "wote, wote," and, so far as I have observed, is only uttered by the male—one of these two, at any rate—the one with the richer and darker back. For five hours I kept a strict eye on the lighter bird, and she never once attempted the bleating; and, while the darker one took frequent excursions over the marsh, the light one was almost constant about the spot where I first flushed it. She was there in attendance when I left the marsh, and I concluded that the eggs had not yet commenced incubation.

During a storm of thunder, lightning, and rain (June 18th) I was attended by the Dunlins of last week, on the self-same spot. They seemed more excited, which I took as a good sign. At intervals I missed one or other of them, for they wandered far over the marsh. I watched them as far as I could see, and I more than half suspected that the missing bird doubled back and returned to the nest, while the other one that stayed bluffed me with his presence. Even during the heavy downpour the bleating came from a height in the air, where the male was flying.

Beginning to feel the dampness, and having accepted the conjecture that I was being outwitted by the strategy of the Dunlins, and that the nest was on some other portion of the marsh, I left her to search a piece of ground two furlongs away, over which I had detected the missing Dunlin flying. The female followed me in this direction, becoming more excited, and I was soon aware of a second Dunlin, calling low in passing me. I at once felt certain I had found the breeding-ground. There were other Dunlins on the marsh, but these passed in hurried flight, piping out the ordinary note. Occasionally, for a distance, they were accompanied by the breeding pair, giving the low notes. Taking up a post that overlooked this last position frequented by the uneasy pair, I was soon convinced that the nest was on the old breeding-ground. Determined to proceed with a method I had formed of quartering the ground, I began striding, while the Dunlins flew anxiously around me, calling all the time. In my very first crossing I was rewarded by finding four baby Dunlins, all huddled together on the wet grass, though they appeared to be only just hatched. They uttered a faint "wee-wee" when I touched them, though they did not gape for food, which partly proved they had recently left the shell. They were shivering, for the air was chill. Not wishing to keep the warmth of the parents from them, I made a hurried survey of the youngsters. They had black legs and bill, and were covered with a fluffy down of black, browns, white, and buffs—a treat to see. Portions of the down on the back and sides of the hinder parts had fan-shaped white tips, which gave such portions a very pretty speckled appearance. On leaving them I came upon a lovely blotched portion of the smaller end of an egg, which I placed in my botanical box, to prove to others the success of my expedition. The fact of finding shells away from the nest suggests that the young are able to use their legs as soon as hatched.

I should have liked one of the eggs to have been addled in my first nest of 1905—the ground colour was such a lovely polished olive, while it is generally greenish blue in these pear-shaped eggs, very glossy, and blotched with different shades of brown and purple. From one of the nests I have a lovely egg, selected to prove my finds, though I remember feeling some qualms of conscience when taking it.

NOTES AND QUERIES.

MAMMALIA.

Notes on the Noctule (Vesperugo noctula).—Of the many Great Bats I have measured, the spread of wings varies from 14⅛ in. to 15 in., but 14¼ in. is the usual expanse. On May 10th, 1875, I examined a Woodpecker's old nesting-hole about thirty feet from the ground in a Scotch pine, and took from it three Great Bats, two of which were females, and one a male. Two more Bats, which appeared to be of the same species, flew out of the hole; so there were five, if not more, in it. On June 8th, 1877, in an old nesting-hole of the Nuthatch, I found three male Great Bats; a fourth Bat escaped.—F. Norgate (20, Anerley Park, S.E.).

Long-eared Bat at Great Yarmouth.—In October last I had a specimen of this Bat (*Plecotus auritus*) brought to me, which had been taken in a house in the town. It soon made itself at home, and two days after would take flies from my fingers. I used to let it fly about the kitchen during the evening. It was fond of hanging by its hind claws to the linen-line, as it looked about for flies, and waving its ears in all directions. Its favourite food was short pieces of small worms, cut up with scissors. I lost it, however, one evening about nine weeks afterwards. — P. E. Rumbelow (2, Napoleon Place, Great Yarmouth).

The Black Rat at Yarmouth.—The two local races of the Black Rat (*Mus rattus rattus* and *M. r. alexandrinus*) appear to be increasing in numbers, several fresh haunts having been brought to my notice. Some young specimens of *alexandrinus* have been through my hands, and all appear to have darker tails than the adults, apparently due to the black hairs being closer together. I have recently had a fine old male of the *M. r. rattus* variety brought me, which had some time previously lost its left hind foot. The tibia had been broken through at about the middle, and the muscles had healed at the knee, leaving about a quarter of an inch of clean bone projecting. The end of the bone was worn and polished, and the animal bore rather a ludicrous resemblance to a man with a wooden leg. The Rat was in good condition, weighing five ounces full. The following measurements of it were carefully taken in the flesh:—Head and body, $6\frac{3}{4}$ in.; tail, 9 in.; ear, $\frac{17}{16}$ in.; vibrissæ, $2\frac{5}{8}$ in.; hind foot, $1\frac{7}{16}$ in.—P. E. Rumbelow (2, Napoleon Place, Great Yarmouth).

AVES.

Chiffchaff in December.—On Dec. 20th, 1905, I shot a Chiffchaff (*Phylloscopus rufus*) from a hedge at Cullercoats, on the Northumberland coast, about three-quarters of a mile inland. This is interesting not only on account of the date, but also because the Chiffchaff is an unaccountably scarce bird even in the summer months in Northumberland. The specimen is being preserved in the Handcock Museum, Newcastle-on-Tyne.—Hugh V. Charlton (Cullercoats, near Newcastle-on-Tyne, Northumberland).

Economical Nesting Habits of the Willow-Warbler (Phylloscopus trochilus) and the Wren (Troglodytes parvulus).—On June 9th, 1905, I found, built among the grass of a dry ditch, a Willow-Warbler's nest containing six eggs, which appeared to be much incubated. These were subsequently taken. On the 14th, when walking near the place, my eye was attracted by a small bird (a Willow-Warbler as it turned out), carrying in its beak a large white feather. On approaching the spot to which it flew, the bird got up, and disclosed a nest in the course of construction, in a very similar position to that found on the 9th. On the next day the new nest appeared to be finished. I then examined the old nest a few yards further along the ditch, and found that the bird had completely dismantled the interior, taking away all the soft white feathers and hair. I have to record a very similar occurrence in connection with a Wren. The nest was found on June 10th, and was built at the end of an elm-bough about six feet from the ground, and near a pond. It was a large nest, with a great deal of lichen on the exterior. It contained three fresh eggs. It is well known that the Wren is extremely jealous of its nest, the mere touch of the human finger being sufficient to cause instant desertion; but there are exceptions, and some years ago I took the only egg from a Wren's nest in the thatch of a hovel, and on two successive mornings repeated the experiment, when it was at last deserted. The Wren under notice, however, acted according to the rule, and deserted. She was "at home" on the 12th, and flew out as I tapped the bough; but the eggs were gone—in fact, she had turned them out, and they lay broken on the ground. On the 14th I did not see the bird, but found on examining the nest that the lining materials had disappeared, as with that of the Willow-Warbler. She had, however, gone a step further, for the lichens, dead grasses, mosses, and leaves which formed the walls and roof of the structure were in the process of demolition. I was unable to see whether the whole nest was removed, as I had to leave the locality that evening. Would she, like the Willow-Warbler, economize and use the materials again for another nest? If so, what would she do with the lining materials which she first removed, as it is obvious the lining of a nest cannot be accomplished until the outer structure is complete, and the materials suitable for the constructional part she removed last of all?—E. F. M. Elms.

Curious Nesting Habit of the Long-tailed Tit (Acredula caudata). On June 12th, 1905, I found a Long-tailed Tit's nest in the centre of a very dense hawthorn, the like of which I have never seen before. The sight of it at once brought to my mind a few lines in an old book in my possession on the subject of the Long-tailed Tit's nest. Thus:—"The nest of the Bottle Tit is sometimes found, but not invariably, with two holes or apertures, one of which is intended, according to Mr. Mudie, for the bird's head to come through, and the other for its tail to come through. . . . . Surely Mr. Mudie, when writing this, must have been misled by some recollection of Porson's famous description of his Satanic Majesty:—

"'His coat was red and his breeches were blue,
With a hole behind for his tail to come through.'"

My nest, however, had neither one or two holes. It had no dome, and the rim of the nest-cup was ragged, suggesting an untidy Chaffinch's nest, for which I at first mistook it. But with an effort and many lacerations I handled one of the young birds, in order to establish their identity, and at the same time I was scolded very severely by one of the parents. It would appear that as the young grew in bulk, and their tails in length, the old birds had torn off the roof so as to give the occupants more room. Indeed, it is somewhat of a mystery how—say, ten—young Long-tailed Tits can emerge from their tiny nest with as many long unruffled tails.—E. F. M. Elms.

Double Brood of Great Tits.—Two broods of Great Tits (*Parus major*) were reared in an apple-tree only a few yards from our house this last season; I saw both clutches of eggs—eight and seven respectively—also the first young ones.—Stanley Lewis (Wells, Somerset).

Late Martins' Nests.—The latest date that I have known for this bird (*Chelidon urbica*) to have young in the nest is Oct. 11th, and this was in the year 1888. Here young in the nest in September may be noted every year. I should like to ask if the Sand-Martin (*Cotile riparia*) usually has late broods. There were young in a nest in Flamborough Cliffs last year on Sept. 2nd.—W. GYNGELL (Scarborough).

The Twite (Linota flavirostris).—It seems very strange to me that we never see this bird on our neighbouring moors, which, well covered with heather, might seem to be admirably suited to its habits. My friends and myself, who are especially interested in birds, spend some days every May in tramping over the moors where the Ring-Ouzel, Golden Plover, and Curlew are thoroughly at home, but we never see a Twite.—W. GYNGELL (Scarborough).

The Breeding Haunts of the Twite.—I have been greatly interested by the correspondence called forth by my remarks on "The Cuckoo and Twite" (Zool. 1905, p. 389). I would like also to thank the correspondents who have written to me privately for their very interesting communications. However, I cannot see any ground for the surprise expressed by Mr. Parkin at my statement that the Twite "breeds in most parts of the British Islands where moors, mountains, and exposed heathy places are found, being by no means confined to the northern parts." Mr. Parkin will find that practically the same is stated in Seebohm's 'British Birds.' It does, indeed, seem probable that the Twite is absent from Wales in the nesting season (Zool. 1902, pp. 5, 6), but this will appear to be the exception which proves the rule when we consider the wide distribution of this bird in Ireland, Scotland, and the North of England. In Ireland it is known to breed regularly in at least twenty-one out of the thirty-two counties, including practically all the counties bordering the coast, and there is reason to believe that it breeds in several others where the fact has not been definitely established. Indeed, in some of the most southern counties—as, for instance, Waterford—it nests abundantly, and its nests have been found even on the remote islands of Kerry. A point, however, which escapes the notice of those whose observation of the breeding habits of the Twite is confined to England, is its preference for the neighbourhood of lofty coasts, especially those which are exposed to the Atlantic. Hence it is much commoner on the western side of our islands than on the eastern. As the bird is said to be especially common on the islands off the coast of Scotland, the Hebrides, the Orkneys, and Shetlands, and outside the British Islands is not known to breed at all except in Norway, where it also chiefly frequents the coasts and islands, we have here a possible explanation why it breeds in the North of England as far south as Derbyshire, but does not breed in Wales. Probably the original breeding habitat of the Twite is in the hilly coast districts bordering the North Atlantic in Ireland, Scotland, and Norway. From Scotland it seems to have spread southwards into England as far as the Pennine Chain extends, these hills being continuous with the Southern Highlands of Scotland; but it has not yet reached Wales, which is an isolated mountain region, the level country between Liverpool and Stafford being a barrier which it has not passed. A glance at the map of the British Islands will show the force of this theory. The keenness of "collectors" in obtaining the eggs is easily understood when we remember that the Twite is, as to its breeding range, one of the most limited of Palæarctic species, as I have above indicated. Probably the greater part of the eggs found in collections have been obtained in the British Islands, where the Yorkshire and Lancashire moors are its most accessible breeding haunt, and a happy hunting-ground of "collectors," who can always get a price for the eggs. The fact that the Twite occasionally places a conspicuous feather in the inside of its nest is mentioned by Mr. Ussher ('Birds of Ireland,' p. 68). Many interesting observations are recorded in that book with regard to species which, like the Twite, are more common in Ireland than in England.—ALLAN ELLISON (Watton-at-Stone, Herts).

Late Stay of Swift, and Notes on the Species.—On Aug. 25th, 1905, I watched a Swift feeding young under the roof of a house in this town, the bird flying up continually. The one young fledged bird was, together with a broken egg, in a House-Sparrow's nest. On Sept. 3rd I saw one Swift flying about midway between Wells and Shepton Mallett; this observation was on a Sunday. The Swift, in its breeding quarters, appears to be an indolent and very disagreeable bird. The House-Sparrows are driven out of their nests, if they chance to be in the way, as soon as the Swifts arrive in the first few days of May; then the two and very often three eggs, rather long and dead white in colour, are deposited about May 24th, after the eggs of the House-Sparrow have been thrown out on the ground, where they lie smashed. It is not uncommon to find two Swifts sitting on the same nest, and many times I have found such a nest to contain three eggs. Through their clumsiness in flying in and out many eggs are perforated by the birds' claws, and lie cracked or broken on the stone, mortar, or board on which the nests are placed; they seem to hold the eggs in their claws while incubating, for I invariably lift the bird sideways with the finger-tips, and when there are eggs it seems to grip them, and on one occasion last summer a bird flew off with an egg on its claw. It is very noticeable, when searching through a colony, how indifferent they are to the human hand; they will not budge from the nest when the tile overhead has been removed, and the only concern they seem to show is when one after the other they are thrown into the air—they generally go off screeching.—Stanley Lewis (Wells, Somerset).

Late Stay of Swift.—On Sept. 16th of last year, with a naturalist friend, I had one of my most interesting experiences of bird migration. Successive flocks of Martins (*Chelidon urbica*) were steadily flying low down over this town, or rather, I should say, past the sea-front of the town, for they flew not over but in front of the tallest buildings. The Martins passed southwards in successive companies, like soldiers on the march, and with them were several Swifts flying with but not amongst the Martins, suggesting the fancy that they (the Swifts) were acting as officers.—W. Gyngell (Scarborough).

Lesser Spotted Woodpecker and Whinchat in Herts, &c.—Both these species appear to be increasing in this district, and the Whinchat nested within five minutes' walk of my house, which is in a fairly populated neighbourhood. Last spring, when I rambled through the woodland in the early morning, I saw and heard daily a great number of Lesser Spotted Woodpeckers. All three British nesting species breed in the woods here—Great and Lesser Spotted and Green species. I also saw a pair of Wheatears here on April 2nd last, which may be considered rare visitors with us, and knew of young Ring-Doves out of the nest as early as April 5th.—W. Percival Westell (5, Glenfernie Road, St. Albans, Herts).

Cuckoo's Egg in Nest of Twite.—In 'The Zoologist' (1904, p. 315) mention is made by my father of a Cuckoo's egg being found in the nest of a Twite by one of my younger brothers. Mr. Allan Ellison (1905, p. 391), in referring to this record, says: "The instance mentioned by Mr. Butterfield can hardly be substantiated"; and Mr. W. H. Parkin (1905, p. 348) also says, in referring to the same instance: "We received a report by a younger brother, ... but we failed to locate it." Both these references can only be interpreted as throwing some doubt on the record, or, at any rate, that it is not satisfactorily confirmed. I well remember the circumstance, as I saw the Cuckoo's egg, which was incubated, the same day. The locality where the Twite's nest was found containing the Cuckoo's egg was the very "colony" with which Mr. Parkin is familiar, and I understood that he knew the particular circumstances under which it was visited at the time. That my brother was familiar with the egg of the Twite is beyond question. The point at issue hangs, then, on the veracity of his statement. I have no reason whatever to doubt that. The evidence is precisely of the same nature as that of Mr. Ellison (1905, p. 391), when he says "he found Cuckoos' eggs in the nest of Chaffinch," &c.; or when Mr. Parkin says (1905, p. 348) he found, in 1899, a Cuckoo's egg in the nest of a Pied Wagtail. I am not surprised at such a capricious bird as the Cuckoo exceptionally depositing its egg in the nest of the Twite. Such occurrences are, of course, rare. Ignoring the testimony of Mr. Wilson, it is sufficiently established that such instances have occurred. I can quite confirm the veracity of Mr. James Ellison's statement, mentioned by Mr. H. B. Booth. No man in the North of England has taken more eggs of the Twite in past years than he has, though it is a pity the egg of the Cuckoo was not actually seen *in situ*. The Twite is a bird that I have been interested in now for some years, especially as regards its distribution in England, and I should like to see its status properly worked out. I am afraid Mr. Allan Ellison's definition (1905, p. 390) of its distribution is open to criticism. I should be very glad if he could give us properly authenticated instances of the Twite breeding in England south of Derbyshire. So far as my own experience and knowledge goes, the Twite in Yorkshire is mainly confined to the hills forming the Pennines; I say mainly, because there are exceptions, a notable one being Thorne Waste, a flat part on the border of the West Riding. Most of the nests are built in ling (*Calluna*), occasionally among the heaths (*Erica* spp.), and exceptionally among grass (*Nardus*). The "colony" referred to by Mr. Parkin among bracken is an exception. I have never known the Twite to nest on carboniferous limestone moors in the West Riding of Yorkshire, nor have I ever heard of an instance. Ling and the heaths are absent on these moors, but the slopes are often covered with bracken. The colony mentioned above in the bracken marks, so far as my knowledge goes, the eastern limit in that direction of the Twite in Yorks. The site chosen is a bracken zone separating, in this case, a grass summit and a wood near the bottom. I should say the colony is at an altitude of from 700 ft. to 800 ft. Whenever I have seen the nests they have been built in the previous year's dead bracken. On the moors to the west of this place, right away across the Pennines to the borders of Lancashire, the Twite breeds in more or less numbers. On the immediate adjoining heather moors to the north I can testify to the breeding of the Twite, though not, as Mr. Parkin says, on "adjoining moors similarly placed," if they be not heather-clad. Although the Twite frequently breeds in colonies, this habit is to some degree dependent on local peculiarities. On long stretches of pretty uniform moorland my experience is that it nests somewhat in scattered numbers; yet, where there are isolated patches of suitable cover and intervening stretches of unsuitable places, they then congregate, and form colonies to meet such contingencies. Two years ago, when I was accumulating evidence on the distribution of this species, Mr. J. A. Harvie-Brown informed me (*in lit.*) that in the Outer Hebrides it nests among marram grass. Mr. Allan Ellison (1905, p. 390) says: "I have . . . . found the nest on a small patch of bogland in Co. Down, under a tuft of rushes on a dry spot where there was no heath, a place remote from any hill." So that the Twite evidently selects its breeding-site to suit local conditions. With regard to the conspicuous feather-adornment of the nest which Mr. Parkin mentions (1905, p. 432), I am sure that this habit is by no means confined to the Twite, whatever purpose such may serve. I have noticed this adornment in the nests of species as diverse as the Twite and Spotted Flycatcher. It is very strange that there is no satisfactory breeding record of the Twite in North Wales. I have had some little experience in trying to substantiate such a record, and I have always been under the impression that if the Berwyn range of hills were systematically searched it would possibly be established as a breeding species in North Wales. The hills there are in many cases heather-clad, similar to the West Riding hills, though of course the formation is Cambrian, while in the West Riding of Yorkshire the formation, which is heather-clad, is mainly millstone grit. According to Messrs. Coward and Oldham, in their 'Birds of Cheshire,' the Twite as a breeding species in Cheshire "is confined to the hill-country of the east." Its southern limit in England, so far as my knowledge goes, is the Pennine Chain and its lateral ridges. We want more information on the subject. Now that the subject is topical, I should be pleased if any readers of 'The Zoologist' would give any definite personal information as to the breeding of this species in Great Britain, especially for any record, if there be any, for counties south of Derbyshire.—ROSSE BUTTERFIELD (Wilsden, Bradford).

Cuckoos' Eggs in Finches' Nests.—The finding of a Cuckoo's egg in the nest of a Bullfinch, Greenfinch, or Linnet is very exceptional. I venture to say that I examine as many of these nests in a year, as well as the other commoner species, as perhaps any man in England, and have found it once with five Greenfinch's eggs, and once with three eggs of Bullfinch—never in a Linnet's nest. The common foster-parents here are Hedge-Sparrows and Pied Wagtails. I may add that I found this egg once with four Chaffinch's eggs, and once in an empty newly-built Spotted Flycatcher's nest. I took the egg, and did not visit the nest again. I have a very unique Cuckoo's egg, which I found with three Hedge-Sparrow's eggs; it is perfectly blue, varying from those of the foster-parents in the thickness of the shell, being a trifle thicker and a shade or two darker in colour; but the remarkable part is that the egg is about the size of a pea. Larger blue eggs are met with exceptionally.—STANLEY LEWIS (Wells, Somerset).

Tawny Owl in a Chimney.—On Nov. 24th, 1905, a Tawny Owl was sent me, which fell dead from the same chimney as the one previously recorded (1905, p. 72), and under similar circumstances. It is most unfortunate that these casualties should have occurred on a property where Owls are quite safe from ordinary risks, and where only a few days before, when the woods were shot through for the first time this season, the request was specially made that any Owls seen should not be shot. This bird, like the last one, was a female, and, as the estate from which it came joins the churchyard on three sides, I have little doubt that it was my old friend whose nest I watched last spring in the church-tower. From the letter which accompanied it, I gather that the chimney is to be covered over with wire-netting at the top to prevent others sharing the same fate. — JULIAN G. TUCK (Tostock Rectory, Bury St. Edmunds, Suffolk).

Breeding of the Hen-Harrier in Cornwall.—It may be of interest to note that the Hen-Harrier (*Circus cyaneus*) still breeds in Cornwall. I know of a quiet place where two can be seen any day of the year, and, until last year, of another couple a few miles distant; but unfortunately one of the latter has been shot. The first named successfully reared three young in the year 1904, but last year, although two eggs were laid in May, they had mysteriously disappeared by June. The nest was a large one, built in an oak-tree about twenty-five yards from the ground. This species is supposed to nest on the ground, but a local man said that the large nest in question was used by the Harriers. I first noticed these rare birds in November, 1903, again in 1904, and several times last summer, and once last November the female only. There are only a few trees—probably not more than fifty—and about two acres of gorse and brake on the steep side of a short valley, four miles from the north coast. Montagu's Harrier apparently breeds in the Lizard district, although I have not been there, so cannot say for certain. The Peregrine and Buzzard may still be seen on our cliffs, but they are much persecuted in some districts, one wealthy landlord offering his gamekeepers a sovereign for every bird of prey destroyed. H. P. O. Cleave (18, Leigham Street, Plymouth).

How does the Osprey carry its Prey?—In reply to Mr. Meiklejohn's query (1905, p. 435), I may say that in Newfoundland, where many years ago I could watch six Ospreys daily from the house I was living in, the fish were invariably gripped by the shoulders, and carried in a parallel position. The birds frequently submerged themselves completely with the force of their plunge; then the tips of the two wings would reappear, and then the bird itself with its prey. I never saw one miss. The fish were Sea-perch, and the scene a narrow inlet of salt water at the end of Placentia Bay.—R. B. Lodge (Enfield).

Early Records.—Mr. O. V. Aplin, in his Oxfordshire Notes (1905, p. 413), mentions the lesser celandine being in flower on Feb. 20th, 1903. In the same year it was in flower here on Feb. 8th. Our earliest date for the Chiffchaff singing is March 24th. Here the Blackbird very rarely sings in January, the 31st being my earliest date. The Tawny Owl and Long-eared Owl are our earliest breeding birds. I have found eggs of both species near here on March 11th.—W. Gyngell (Scarborough).

Bird Notes from Shetland (May to November, 1905).—

Land-Rail (*Crex pratensis*).—First heard, 2 a.m., May 16th.

Martin (*Chelidon urbica*).—One seen at Cliff Loch, May 19th.

Swallow (*Hirundo rustica*).—One at Uyeasound, 3 p.m., May 25th.

Wood-Pigeon (*Columba palumbus*).—One in garden at Halligarth, May 25th.

Rock-Pigeon (*C. œnas*).—Becoming more plentiful.

White-tailed Eagle (*Haliaëtus albicilla*).—One seen, June 1st.

Shag (albino) (*Phalacrocorax graculus*).—An albino Shag was pointed out to me at Bunafirth on June 22nd.

Rock-Pipit (*Anthus obscurus*).—Found nest with three pink eggs on June 28th. The eggs are not unlike the pink variety of Tree-Pipit's, but larger.

Tree-Sparrow (*Passer montanus*).—My niece found a nest with five eggs, on June 28th. in the garden, not far from where I found the former nest (*cf.* Zool. 1903, p. 462).

Sky-Lark (albino) (*Alauda arvensis*).—Brought to me alive on Aug. 18th.

Scops Owl (*Scops giu*).—On or about Aug. 20th a small Owl was caught on the Lighthouse Rock. It was kept for a few days by the keepers, who fed it on flies and beetles. From the careful description given to me by the native who used to shoot birds for my father, this Owl could only have been an example of the Scops Owl. Unfortunately the bird died, and there were no means of sending it to me, and none of the keepers knew how to skin or preserve it, and it never occurred to them to keep a wing or even some feathers; so the bird was lost.

Ring-Ouzel (*Turdus torquatus*).—The only occasion on which I have seen this bird in Shetland was on Oct. 27th at Halligarth, when the bird rose from a bush almost within arm's length of me, and settled on a tree close at hand. I was only armed with a telescope, and while having a good look at the bird a couple of Merlins and some Hooded Crows came careering overhead, and scared the Ouzel away. It just seemed to fall away from the branch on which it was sitting, and was immediately lost to sight.

Swan (Whooper) (*Cygnus musicus*).—Two at Baltasound, Oct. 27th.

Rook (*Corvus frugilegus*).—A few seen on Nov. 7th.

Bullfinch (*Pyrrhula europæa*).—One shot on Nov. 21st. The bird was a male in fine plumage, measuring 6·12 in., and weighing one ounce and seventy grains.—T. Edmondston Saxby (Halligarth, Baltasound).

Black-throated Diver (Colymbus arcticus) at Woburn. — On Tuesday last (Jan. 9th) a Black-throated Diver, which I had noticed for several days on one of our ponds, was found dead. I took it to the Natural History Museum, South Kensington, where it was pronounced to be a young bird.—J. W. Bedford (Duchess of Bedford) (Woburn Abbey, Woburn).

PISCES.

Flying Fish near Ramsgate.—Seldom is one placed in the position of public critic of one's own defects or omissions, but into that predicament I am herewith landed; so I need not spare the rod, knowing on whose shoulders it falls. In a communication to 'The Zoologist' (1905, p. 401), among other remarks, I ventured to say, relative to the Medway and Swale specimens:—"In so far as we are aware, the two fishes in question are the only authentic evidence of the presence of species of Flying Fish (*Exocœtus*) on the Kent shores." This statement, though made quite sincerely at the time, nevertheless has now to be refuted. Since the publication in question I have quite accidentally come across the record of a capture on the Kent coast some forty years ago. This appeared in 'Land and Water,' vol. iv. p. 206 (Oct. 19th, 1867). In a paragraph signed "A Soldier" it narrates how that, "a few years ago, when walking on the sands between Ramsgate and Broadstairs with Major J. C. G. and Mr. C., ... we met an old fisherman much employed by the visitors on that coast to collect sea productions, carrying in his hands a Flying Fish alive and in a lively state." The writer goes on to say that he and the major had made several voyages to the East Indies, and could not be mistaken in their identification of the fish. Judging from the context, the trio of friends were in such eager argument over the ins and outs of the case, and so astonished how such a tropical form reached our shores, that, as admitted to their regret, they omitted securing the specimen from the "old salt." What ultimately became of it is doubtful. What species it was, of course, we know not, but the incident supports the view previously suggested of the presence of Flying Fish on the British coasts oftener than in the tabular data given in my paper (*loc. cit.*).—J. Murie (Leigh-on-Sea, Essex).

NOTICES OF NEW BOOKS.

Nature in Eastern Norfolk. By Arthur H. Patterson. Methuen & Co.

This book is devoted to the fauna of Great Yarmouth and its vicinity, and our readers will remember a number of faunistic papers contributed by the author to these pages during the last few years. These revised and enlarged form a very large portion of the volume, and constitute a handbook that will be indispensable to naturalists who explore that once famous and still more than interesting district.

The chapter devoted to "Some General Observations on the Fauna" will prove the charm of the book to those whose zoological proclivities have not attained the purely special character. We read of the changes that can take place, principally by the agency of man, in a local fauna during the term of a single human life; the reminiscences of hardy and obscure folk who gained a precarious livelihood as wildfowlers, better known as "Breydoners"—are well, sympathetically, and racily told; and there is a welcome record of the more favoured local collectors, mostly of a bygone time, and the rarities which came into their possession. But many a rare bird has been killed and unrecognized in this favoured locality. "It is on record that Lilly Wigg, an old-time Yarmouth naturalist, cooked and ate a Red-breasted Goose (*Bernicla ruficollis*), and did not even guess its species until the feathers afterwards attracted his attention." Birds alone have not become scarcer in Eastern Norfolk; mighty Perch (*Perca fluviatilis*), of which captures are recorded weighing four to four and a half pounds, are not heard of now; large examples are less frequently taken, and "it is said that the *Anacharis* weed has injuriously invaded many of the Perch's spawning quarters."

Twelve coloured illustrations by Mr. F. Southgate add to the value of this excellent narrative of a local fauna.

The Birds of Hampshire and the Isle of Wight. By the Rev. J. E. Kelsall, M.A., and Philip W. Munn, F.Z.S., &c. Witherby & Co.

Every student and lover of British Birds eagerly anticipates and welcomes the appearance of a county volume, especially when the district is his own, or one of his favourite localities; we Surrey men are vastly interested in the fauna of the beautiful county just over one of our borders; most naturalists are alert when the New Forest is mentioned, and no little interest appertains to the birds of the Isle of Wight. Consequently this is a volume that will quickly find its way on many shelves, especially those of the readers of 'The Zoologist,' who have so long been made interested in at least one part of Hants by our old contributor Mr. Corbin; but above and beyond all, the county contains Selborne, the home of Gilbert White, whose book has long since gained the position of an English classic, and is neglected by no reader of English literature.

Two hundred and ninety-four species are enumerated; of these eighty-five are residents, forty-two summer visitors, seventy winter (including spring and autumn) visitors, thirty-six occasional, and sixty-one accidental visitors—a formidable list compared with the one hundred and twenty recorded by White as found at Selborne only. Very much information has been garnered respecting each species, and records diligently consulted; so that the work may fairly claim to be "up to date."

We have only noted two errors in reading these interesting pages—one a mistake, the other a misprint. In the bibliography we read "Letters of Rusticus, edited by Edward Newman." The first editor of 'The Zoologist' did *not edit*, but was *the author* of that volume. The misprint is in the spelling of the name of Col. Feilden.

The work is well illustrated from actual photographs, and an excellent map is also given.

Eggs of the Birds of Europe, including all the Species inhabiting the Western Palæarctic Area. By H. E. Dresser, F.L.S., F.Z.S., &c. Part I. Published by the Author.

We gladly call attention to the first part of this beautiful and useful publication. Not only are the coloured figures of the eggs all that can be desired, and an advance on some previous productions, but the text also contains many blocks illustrating rare or not commonly known nests. No particular system of classification is adopted, as the part commences with *Circus æruginosus*, and other allied *Falconidæ*, and the second half is devoted to the *Sylviinæ*. We need scarcely remark that the writer of 'The Birds of Europe' is quite at home, and can be relied on in the text.

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